CONFERENCE OF THE EIGHTEEN-NATION COMMITTEE ON DISARMAMENT

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Letter dated 29 July 1968 from the Representative of Sweden to the Special Representative of the Secretary-General of the United Nations

Enclosed with this letter you will find a copy of a press release issued by the International Institute for Peace and Conflict Research in Stockholm on June 29, 1968, regarding two meetings of seismological experts which took place in Sweden in April and June of this year. Attached to the press release is a Summary Report, adopted by this group of experts on seismic methods for monitoring underground explosions.

The International Institute for Peace and Conflict Research in Stockholm (SIPRI) is a non-governmental international institution, which was set up two years ago through a decision of the Swedish Parliament which also allocates the main funds for its activities. The governing bodies and the personnel of the Institute are, however, international. The Swedish Government is thus not involved in or responsible for the actions or publications of the Institute.

As this documentation would seem to be of interest to other delegations in the ENDC I hereby request you to circulate this letter with the enclosed press release and Summary Report as an ENDC -document.

(signed) Alva Myrdal
Chairman of the Delegation

GE.68-13679
68-18547

SIPRI
INTERNATIONAL INSTITUTE FOR PEACE AND CONFLICT RESEARCH
Sveavägen 166, 113 46 Stockholm, Tel. 34 96 00

Press Release

Stockholm, June 29, 1968, at 2 p.m.

The group of seismological experts from 10 countries including four nuclear powers which met at Tällberg, Dalarna, last Monday adjourned yesterday after having unanimously adopted a joint report assessing today's state of the art of seismic test ban verification. The meeting was the second of two by the Stockholm International Peace Research Institute (SIPRI).

The plan is to publish the experts' report as soon as possible preferably before the resumption of the Geneva disarmament conference on July 16, in order to provide a technical background for those who have to make political judgements in different countries.

The main feature of the report is the recognition that it is now possible to distinguish large and medium-sized underground explosions from interfering earthquakes. This provides a new situation in test ban control. The report includes no political judgement of the sufficiency of available capabilities.

An assessment of the state of the art of seismic test ban control cannot alone indicate whether sufficient security can be achieved or not. But it is a necessary ingredient for political decision-making. Other ingredients are assessments of the security risks of cheating by the other parties if it is not disclosed, the need for additional measures as on-site-inspections, the military significance of difficult-to-disclose small tests, and the general feasibility of stopping all testing and by that restricting weapons development. This last point is closely related to procurement of ABM systems.

Seismic methods for monitoring underground explosions: An assessment of the Status and Outlook

Summary of Report of SIPRI Seismic Study Group, April and June 1968

Considerable progress in the field of detection and identification of underground explosions and earthquakes has been made since 1960, when technical talks

were held on this subject in Geneva. At that time the prospect of identification of explosions as such was considered remote. On the initiative of SIPRI an expert study group was convened to review and assess the present possibilities of detection and identification by seismological means alone of underground explosions and earthquakes. In the work of the group, seismologists from the following ten countries took part:

Canada
Czechoslovakia
France
India
Japan
Rumania
Sweden
Union of Soviet Socialist Republics
United Kingdom
United States of America

The study group considered these developments in order to assess the state of the art in different countries, to find areas of consensus, to probe unclear or controversial areas and to point out promising areas for further research and development. One of the main tasks of the group was to examine the usefulness of networks for the detection and identification by seismological means only of underground explosions. The members of the study group presented the most recent results and arrived at the conclusions summarized below.

(1) Since 1960 improvements in the fields of instrumentation, seismological theory and interpretation of observations have been achieved, and networks of standardized instruments (reporting to data centres, for example the I.S.C. at Edinburgh and B.C.I.S. at Strasbourg) have been deployed. Research and development of this type had been recommended by the Geneva Conference of Experts. This and other encouragement to research has led to the establishment of several seismological networks and stations. Two of them are particularly large and homogeneous, one consisting of about 100 widespread single stations. One of these systems is the national system deployed on the territory of the USSR. The other, the so-called WWSSN (World Wide Standard Seismological Network) system, is on the territories of the USA and many other countries of the world. The former system is within the territory of the USSR, whereas the latter is external to the USSR and is worldwide.

This distribution results in the better capability of the latter system to detect and identify underground explosions of interest. In addition ten arrays */ have been established for research purposes, some of which contribute data to international data centres.

(2) It was reported that the problems of detection using body waves by such networks as WWSSN and contributing arrays are less severe than those involved in identification. American and British participants reported that identification by the WWSSN network is possible for explosions in the Northern Hemisphere down to the level of 20 to 60 kilotons exploded in hard rock like granite. This progress has depended on the traditional seismological data exchange between countries.

(3) Both major systems mentioned in paragraph 1 are able to locate within 10 to 40 kilometers the site of explosions in the range of yields mentioned above.

(4) It was however recognized that for explosions in less dense materials, like Nevada tuff (a porous volcanic rock) and alluvium, the yield corresponding to the identification limit mentioned above would be increased two (tuff) to ten times (alluvium), depending in the latter case on the water content. The maximum possible yield in alluvium would be limited by the thickness of the alluvium layer, and by the possible requirement to prevent cratering. For example, if the layer is 450 meters thick, the maximum fully contained yield would be of the order of 20 kilotons.

(5) Another case of reduced signal strength is that of an explosion in a specially prepared underground cavity. Small scale experiments in the USA and UK have been made during the last few years, the largest of which was reported to be a nuclear explosion of 0.35 kilotons. All confirmed the theoretically predicted reduction of signal strength by a factor of about one hundred. It was recognized that there may be considerable practical limitations to do this with yields above 10 kilotons. Some participants expressed the opinion that large decouplod explosions might be detected by radioactive leakage, subsidence craters and by other means.

(6) Although the emergence of a method for positive identification of explosions has made the annual number of corresponding earthquakes less important than in the past, earthquake statistics are still pertinent to the problems associated with an

*/ An array is a complex of seismometers spread over a wide area and connected to a central point.

underground test ban. The worldwide yearly number of earthquakes corresponding to a 20 kiloton explosion in tuff, has been observed to be about 2000. The number corresponding to 2 ± 1 kilotons exploding in granite, was estimated to be somewhere between ten and twenty thousand. These observations and estimates are based on four years of observations, obtained from the data centre of the WWSSN. The Soviet data indicate that these numbers of earthquakes should be reduced by a factor of two. The large numbers of earthquakes at the lower yield equivalence would be expected to cause some problems of interference.

(7) The criterion providing the method of positively identifying explosions by seismological means alone employs the difference in the relative excitation of body and surface seismic waves between explosions and earthquakes. */ This technique requires that seismic waves from explosions are not masked by signals from other events.

(8) At the yields referred to above (20-60 kilotons in granite), the measurements of these seismic waves recorded by the WWSSN network give a clear separation of explosions and earthquakes. The existing experimental evidence on the usefulness of the surface wave method for identification of explosions with lower yields is as yet inconclusive. The long period instruments in the WWSSN are not sensitive enough to record the surface waves from low yield explosions at great distances. UK, Canadian, American and USSR research indicates separation of explosions and earthquakes down to 10 kilotons in hard rock. Studies at shorter distances are inconclusive as to the validity of this discriminant for yields below 10 kilotons in hard rock.

(9) The majority of the participants believe that other criteria, such as
Depth at which the event takes place,
Direction of the first ground motion at recording stations,
Frequency content of seismic waves,
Excitation of shear waves,
Complexity of the seismic record

*/ A surface wave is a wave of long period running along the surface of the Earth; a body wave is a short-period wave running through the deep interior of the Earth.

do not at present provide positive identification. However, ideas were presented on how such criteria could be combined, by standard statistical procedures, for more effective utilization of the data.

(10) Improvements in identification can be expected in the foreseeable future from application of current research results. Immediate improvement of existing networks could be obtained, for example by moving stations from disturbed to quiet locations or establishing satellite stations in certain cases. A similar example of a more costly improvement would be the installation of about thirty highly sensitive long period seismographs, of a kind only recently developed, at certain stations of the WWSSN network. It would lower the detection threshold for surface waves by a factor of about ten but the discriminant is at present unproved below 10 kilotons in hard rock.

In addition the implementation of more arrays would make it possible to conduct research into whether the identification of explosions in the 2-10 kT range in granite is possible, and would enable the design of suitable monitoring systems if the results so warrant.

(11) Implicit in the projections above are recommendations for network developments based on present research results.

(12) The group also saw that the following fields for research could be profitable:

(a) methods of improving surface wave detection

(b) more detailed work on the relative excitation of body and surface waves by earthquakes and explosions

(c) pattern recognition of seismic records

(d) statistical treatment of identification criteria for decision applications.

(13) The effectiveness of this programme of research, as well as progress in the efforts to lower the thresholds of detection and identification, would be greatly increased if existing networks could merge into one worldwide data exchange system.

L. Constantinescu
U. Ericsson
E. Herrin
V. Kárník
P. Mechler
S. Miyamura
I. Pasechnik
F. Press
H. Thirlaway
K. Whitham
T. Varghese

Tällberg, Sweden, June 28, 1968.